Ectopia Cordis in a Crested Gecko (*Rhacodactylus ciliatus*)

Raffaele Melidone[1], Dr Med Vet, Joerg Mayer[2], Dr Med Vet, MSc, DABVP (ECM), Kathryn M. Wrubel[3], PhD

1. Department of Veterinary Pathology, Tufts Cummings School of Veterinary Medicine, North Grafton, MA 01536-1895, USA

2. Department of Clinical Sciences, Tufts Cummings School of Veterinary Medicine, North Grafton, MA 01536-1895, USA

3. InTown Veterinary Group, Massachusetts Veterinary Referral Hospital, Woburn, MA 01801, USA

Abstract: A newborn male crested gecko (*Rhacodactylus ciliatus*) was presented for evaluation immediately after birth because of a bright red movable and pulsating mass emerging from the ventral midline of the rib cage. On physical exam the animal was extremely depressed, and the bright red thoracic mass reported by the owner was identified as a beating heart. The gecko died a short time after presentation and was submitted for a postmortem examination. Gross examination revealed that the entire heart and some adipose tissue were protruding through a 0.4 cm × 0.2 cm elliptical congenital cutaneous cleft located on the ventral aspect of the caudal rib cage. No other gross abnormalities were detected. To the best of our knowledge, this is the first case report of ectopia cordis in a gecko.

Key Words: congenital malformation, ectopia cordis, gecko, heart, *Rhacodactylus ciliatus*.

Case Report

A newborn, 6-cm-long male crested gecko (*Rhacodactylus ciliatus*) was presented to Tufts University Cummings School of Veterinary Medicine (North Grafton, Massachusetts) for a bright red mass protruding from the ventral caudal rib cage through a 0.4 cm × 0.2 cm elliptical cutaneous cleft (Fig. 1). The animal was alive and vital immediately after birth but depressed at presentation a day later. The mass protruding from the cutaneous cleft was identified as the heart, which was still beating. The animal progressively deteriorated and died shortly after presentation. No diagnostic tests were performed before death.

The gecko was submitted for postmortem examination, which revealed that the entire heart and a small segment (0.2 cm × 0.2 cm) of adipose tissue was protruding through a 0.4 cm × 0.2 cm elliptical cutaneous cleft located on the caudal medial ventral aspect of the rib cage (Fig. 1). No other macroscopic abnormalities were detected.

After gross examination, the entire body of the gecko was fixed in 10% buffered formalin for 72 h and routinely processed according to accepted histological techniques. Five micrometer-thick sections were stained with hematoxylin and eosin for microscopic examination. Microscopically, the heart protruded through a cleft of the cutaneous squamous epithelium. The squamous epithelium of the caudal portion of the congenital cutaneous cleft was invaginated caudally (Fig. 2). The cranial portion of the cutaneous cleft was not evaluated due to the superimposition of the front limb. No other significant microscopic abnormalities were detected.

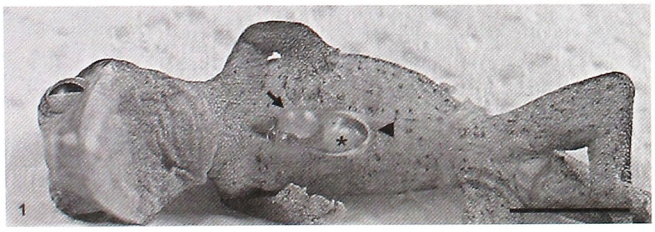

Figure 1. Crested gecko, the entire heart (arrow) and a small segment of adipose tissue (asterisk) protruded through a 0.4 cm × 0.2 cm elliptical cutaneous cleft (arrowhead). Bar = 5 mm.

Discussion

The heart of a squamate is comprised of two atria and one ventricle, further subdivided into three ventricular chambers. A distinct muscular ridge forms an incomplete

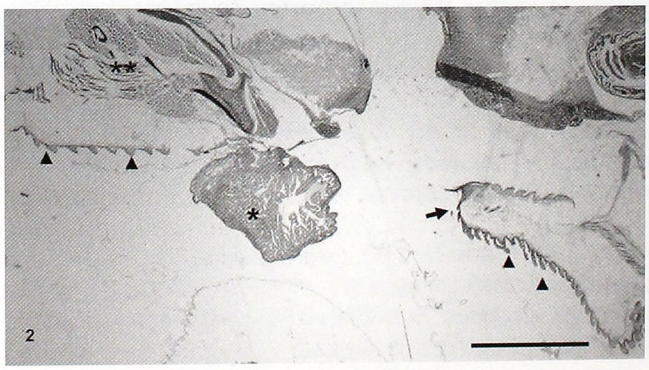

Figure 2. Crested gecko, tangential section through the cutaneous cleft and forelimb (double asterisk).The heart (asterisk) is protruding through a cleft of the cutaneous squamous epithelium (arrowheads). The squamous epithelium of the caudal portion of the congenital cutaneous cleft was invaginated caudally (arrow). Hematoxylin and eosin. Bar = 2 mm.

septum that separates the ventricle into a large cavum dorsale and a smaller cavum pulmonale. The cavum dorsale is further subdivided into a cavum venosum and a cavum arteriosum by a septum, the ventral septum (Hicks *et al.*, 1996). In the embryo, the primitive heart is a single median structure that develops ventromedially to the foregut. Initially, it is composed of a simple endothelial tube; however, soon thereafter it becomes surrounded by mesoderm and forms the myocardium and the epicardium. The cranial portion of this tube subsequently forms the ventricles and truncus arteriosus, whereas the caudal portion of the tube forms the atria and the sinus venosus (Dyce *et al.*, 1996).

Ectopia cordis is a rare developmental anomaly characterized by abnormal positioning of the heart outside the thorax (Tongsong *et al.*, 1999). This developmental anomaly has been reported previously in several species, including humans, dogs, pigs, pigeons, cattle, and reptiles (Windberger *et al.*, 1992; Elsey and Joanen, 1994). In humans, ectopia cordis is usually found in association with Cantrell's pentalogy, which is a complex syndrome characterized by multiple malformations: midline supraumbilical abdominal wall defect, split lower sternum, anterior diaphragmatic defect, pericardial defect, and several forms of cardiac diseases (Tongsong *et al.*, 1999). All the abovementioned congenital defects may not be present at the same time in patients with Cantrell's syndrome (Tongsong *et al.*, 1999).

Ectopia cordis is a rare developmental anomaly in reptiles and has only been reported once in alligators (Elsey and Joanen, 1994). In mammals, it is subdivided into three different types: cervical (superior and inferior), sternal, and abdominal (Windberger *et al.*, 1992). Ectopia cordis is most often associated, in mammals, with ventricular septal defect, atrial septal defect, pulmonary valve atresia, single ventricle, cardiac diverticulum, aortic valve atresia, anomalous venous return, Tetralogy of Fallot, and transposition of great vessels (Tongsong *et al.*, 1999). None of the aforementioned abnormalities were noted in this case, although the size of the gecko partially impaired a complete examination of the major vasculature and potential atrial septal defects. Most reptiles, except crocodilians, do not have a complete interventricular septum.

The etiology for ectopia cordis has not been established in humans (Tongsong *et al.*, 1999); however, a few cases of ectopia cordis have been reported to be associated with triploidy, trisomy 18, and familial X-linked inheritance (Tongsong *et al.*, 1999). An attempt to identify a chromosomal defect linked with ectopia cordis in calves was not successful (Windberger *et al.*, 1992). Several abnormal chromosomes were observed, but none of the alterations could be directly linked to great vessel malformations or ectopia cordis (Windberger *et al.*, 1992). No study has been done to evaluate a link between ectopia cordis and a chromosomal defect in a reptile.

The exact pathogenesis of congenital malformations in reptiles has been investigated and some hypotheses have been postulated (Ji *et al.*, 2002). It has been well documented that incubation temperature influences the length of the incubation and, in some species, also influences sex determination of the developing embryo (Denardo, 2006). It also has been demonstrated that variations in the incubation temperature will affect, to some degree, the developmental rates of the offspring phenotypes (Bell *et al.*, 2006). In this population, congenital abnormalities were not reported in a previous clutch from the same parents and incubation parameters (temperature, humidity, and substrate) did not significantly vary between clutches (eggs were incubated at a temperature range of 24–25°C (76–78°F) on perlite; the humidity levels within the incubator and substrate were not measured). Environmental toxins also can cause developmental abnormalities. Deformities may range from those that can be compatible with the life, such as a small carapace or tail deformities, to those considered incompatible with life, such as ectocardia or the absence of a carapace and/or plastron (Bell *et al.*, 2006). No known exposure to environmental contaminants was reported in this case. Despite the attempts made to explain the pathogenesis and etiology of ectopia cordis in vertebrates, a definitive single cause has not been given. To the best of our knowledge, this is the first case report of ectopia cordis in a gecko.

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